

What is claimed is:

09989930.4.4.10.1  
1. An ultra-low carbon steel having a chemical composition including, in  
mass percent, C: at most 0.010%, Si: at most 0.5%, Mn: at most 1.5%, P: at most  
5 0.12%, S: at most 0.030%, Al: at most 0.080%, N: at most 0.0080%, one or both  
of Ti: at most 0.10% and Nb: at most 0.05%, B: 0 - 0.0050%, V: 0 - 0.05%, Ca: 0  
- 0.0050%, and at most 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable  
components, wherein the total number of non-metallic inclusions observed in 60  
fields under a microscope in a sample of the steel prepared in accordance with JIS  
10 G0555 is at most 20.

2. An ultra-low carbon steel as claimed in claim 1 wherein the chemical  
composition further includes B: at most 0.0050%.

15 3. An ultra-low carbon steel as claimed in claim 1 wherein the chemical  
composition further includes V: at most 0.05%.

4. An ultra-low carbon steel as claimed in claim 2 wherein the chemical  
composition further includes V: at most 0.05%.

20 5. An ultra-low carbon steel as claimed in claim 1 wherein the chemical  
composition further includes Ca: at most 0.0050%.

25 6. An ultra-low carbon steel as claimed in claim 2 wherein the chemical  
composition further includes Ca: at most 0.0050%.

7. An ultra-low carbon steel as claimed in claim 3 wherein the chemical  
composition further includes Ca: at most 0.0050%.

8. An ultra-low carbon steel as claimed in claim 4 wherein the chemical composition further includes Ca: at most 0.0050%.

5 9. An ultra-low carbon steel as claimed in claim 1 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

10 10. An ultra-low carbon steel as claimed in claim 2 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

15 11. An ultra-low carbon steel as claimed in claim 3 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

12. An ultra-low carbon steel as claimed in claim 4 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

20 13. An ultra-low carbon steel as claimed in claim 5 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

25 14. An ultra-low carbon steel sheet made of a steel having a chemical composition including, in mass percent, C: at most 0.010%, Si: at most 0.5%, Mn: at most 1.5%, P: at most 0.12%, S: at most 0.030%, Al: at most 0.080%, N: at most 0.0080%, one or both of Ti: at most 0.10% and Nb: at most 0.05%, B: 0 - 0.0050%, V: 0 - 0.05%, Ca: 0 - 0.0050%, and at most 0.1% of each of Cu, Cr,

Sn, and Sb as unavoidable components, wherein the total number of non-metallic inclusions observed in 60 fields under a microscope in a sample of the steel prepared in accordance with JIS G0555 is at most 20.

5           15. An ultra-low carbon steel sheet as claimed in claim 14 wherein the chemical composition further includes B: at most 0.0050%.

10           16. An ultra-low carbon steel sheet as claimed in claim 14 wherein the chemical composition further includes V: at most 0.05%.

15           17. An ultra-low carbon steel sheet as claimed in claim 15 wherein the chemical composition further includes V: at most 0.05%.

20           18. An ultra-low carbon steel sheet as claimed in claim 14 wherein the chemical composition further includes Ca: at most 0.0050%.

25           19. An ultra-low carbon steel sheet as claimed in claim 15 wherein the chemical composition further includes Ca: at most 0.0050%.

            20. An ultra-low carbon steel sheet as claimed in claim 16 wherein the chemical composition further includes Ca: at most 0.0050%.

            21. An ultra-low carbon steel sheet as claimed in claim 17 wherein the chemical composition further includes Ca: at most 0.0050%.

            22. An ultra-low carbon steel sheet as claimed in claim 14 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

23. An ultra-low carbon steel sheet as claimed in claim 15 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

5        24. An ultra-low carbon steel sheet as claimed in claim 16 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

10       25. An ultra-low carbon steel sheet as claimed in claim 17 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

15       26. An ultra-low carbon steel sheet as claimed in claim 18 wherein the chemical composition further includes a maximum of 0.1% of each of Cu, Cr, Sn, and Sb as unavoidable components.

20       27. A method of manufacturing an ultra-low carbon steel sheet in which molten steel having a chemical composition including, in mass percent, C: at most 0.010%, Si: at most 0.5%, Mn: at most 1.5%, P: at most 0.12%, S: at most 0.030%, Al: at most 0.080%, N: at most 0.0080%, one or both of Ti: at most 0.10% and Nb: at most 0.05%, B: 0 - 0.0050%, V: 0 - 0.05%, and Ca: 0 - 0.0050% is subjected to refining in a converter, secondary refining after refining in the converter, continuous casting, and then hot rolling, wherein at the time of the secondary refining, the molten steel is tapped into a refining vessel, a vacuum immersion pipe having an interior that can be adjusted to a negative pressure is  
25       immersed in the molten steel in the refining vessel, and a stirring gas is blown into the molten steel.

28. A manufacturing method for an ultra-low carbon steel sheet as claimed in claim 27 wherein the amount of FeO + MnO in the slag in the refining vessel is at most 15 mass %, and the throughput at the time of casting is at most 5 tons per minute.

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29. A manufacturing method for an ultra-low carbon steel sheet as claimed in claim 27 wherein the hot rolling of a slab obtained by the continuous casting is commenced after making the average temperature of the slab at least 1100°C, the finishing temperature of hot rolling is made at least the Ar<sub>3</sub> point, and the coiling temperature is made 450 – 750°C.

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30. A manufacturing method for an ultra-low carbon steel sheet as claimed in claim 29 wherein in the hot rolling, heating or temperature holding process for a short period of time is carried out after rough rolling, and the finishing temperature of hot rolling is made at least the Ar<sub>3</sub> point over the entire length of a hot rolled coil.

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31. A method of manufacturing an ultra-low carbon steel sheet as claimed in claim 27 wherein the obtained hot rolled steel sheet is subjected to descaling, cold rolling with a reduction of at least 45%, and annealing, with soaking being carried out at a temperature of at least 650°C when the annealing treatment is batch annealing and at a temperature of at least 750°C when the annealing treatment is continuous annealing, and then temper rolling is carried out.

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32. A method of manufacturing an ultra-low carbon steel sheet as claimed in claim 28 wherein the obtained hot rolled steel sheet is subjected to descaling, cold rolling with a reduction of at least 45%, and annealing, with soaking being carried out at a temperature of at least 650°C when the annealing treatment is

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33. A method of manufacturing an ultra-low carbon steel sheet as claimed  
5 in claim 29 wherein the obtained hot rolled steel sheet is subjected to descaling,  
cold rolling with a reduction of at least 45%, and annealing, with soaking being  
carried out at a temperature of at least 650°C when the annealing treatment is  
batch annealing and at a temperature of at least 750°C when the annealing  
treatment is continuous annealing, and then temper rolling is carried out.

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34. A method of manufacturing an ultra-low carbon steel sheet as claimed in claim 30 wherein the obtained hot rolled steel sheet is subjected to descaling, cold rolling with a reduction of at least 45%, and annealing, with soaking being carried out at a temperature of at least 650°C when the annealing treatment is

15 batch annealing and at a temperature of at least 750°C when the annealing treatment is continuous annealing, and then temper rolling is carried out.